ELECTRONIC DATA COLLECTION IN SELECTED BLS ESTABLISHMENT PROGRAMS

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ABSTRACT

Since the mid-1990's, the Bureau of Labor Statistics (BLS) has been using Electronic Data Interchange (EDI) and World Wide Web (WWW) to collect establishment survey data. The primary purpose of these electronic data collection efforts is to increase employer participation in BLS surveys by reducing their reporting burden and costs. Likewise, BLS benefits as it generally receives more comprehensive and timely data; reduces data processing (handling, data entry, etc.,) and postage costs; and frees up more staff time for data analysis and dissemination activities. This paper describes how BLS has pursued these electronic data collection approaches and discusses results to date.

Key Words: World Wide Web, Electronic Data Interchange, EDI, E-mail, Internet, Establishment Surveys, CSAQ, CASIC

1. INTRODUCTION

The use of advanced technology has been the most significant improvement in survey data collection of the past 20 years. A wide array of methods has been developed as computer processing power has been made available first to survey organizations and then to the respondents. This vast availability of computing and communications power is changing data collection in ways that will reduce costs and respondent burden. This paper describes two such methodologies in the context of selected BLS programs: World Wide Web (WWW) and Electronic Data Collection (EDI). The particular frames of reference are the Current Employment Statistics (CES) and Covered Employment and Wages (CEW) or ES-202 programs.

1.1 Evolution of Electronic Data Reporting

The growing access to our respondents of advanced microcomputers spurred the development of Computerized Self-Administered Questionnaires (CSAQ) in the 1980s. Under CSAQ, survey organizations supply respondents with the necessary software, sent either on diskettes or electronically. Respondents load the provided software on their PCs, and use the system for entering and editing their own data. Thus, CSAQ methods are much like Computer Assisted Telephone Interviewing (CATI) except the software acts as the interviewer. As in CATI, CSAQ can contain branching and on-line editing.

Over the past several years, the availability of centralized databases has led to the emergence of Electronic Data Interchange (EDI), also known as Electronic Commerce (EC). EDI allows large multi-unit organizations to report large volumes of data in standardized formats, thereby reducing respondent burden and data collection costs. These data are transmitted electronically, making them instantly available for use in the survey.

The primary goal of Computer Assisted Survey Information Collection (CASIC) has been to improve the quality of data collected and edited at the source, while controlling error sources from interviewers through computer-driven branching. These methods have offered improvements in data quality and timeliness and/or reduced costs.

The promise of widespread and instant access via the Internet and the WWW has already spurred research into the potential for improving surveys. The major focus of the early research has been in surveys of business establishments, where Internet access has penetrated much further than in households.

1.2 Advantages of WWW for Data Collection

With the Internet and WWW providing an inexpensive and easy-to-use communications framework, and building on widespread availability of high-powered desktop computers, WWW reporting is the next logical step in CASIC evolution. WWW data collection embodies all of the strengths of advanced telephone procedures of the 1980s, such as improved timeliness and on-line editing. It simultaneously eliminates many of the weaknesses, including the high costs of interviewers. It allows the user to enter data using a visually interesting interface. Links to other related sites can be provided, giving the respondent access to survey data products.

The WWW offers what may be the lowest cost survey environment, especially for ongoing surveys. Cost reductions mirror those of Touchtone Data Entry (TDE) and CSAQ for on-line entry and editing, and far surpass any CASIC method for costs of transmissions. The unit-cost per questionnaire is significantly reduced through the elimination of postage charges and the many labor-intensive activities of mail collection and by significantly reducing telephone fees and labor costs for edit, prompting, and collection calls.

A major feature of this method is that the WWW is truly on-line. In ways beyond CATI and CSAQ, WWW offers instantaneous response to virtually any request posed by a respondent. The improvements offered by automation and electronic communication will ultimately lead to simplified respondent reporting, more accurate data, more timely responses, and improved customer access to our survey products. Survey organizations have worked diligently to associate the utility and importance of the published information with data reporting by individual respondents. The WWW interface could take this effort to a new level by profiling the data provided by individual respondents against, for example, other data on their industry, their state, and the nation. Also, the WWW's multi-media capabilities will enable survey organizations to provide on-line "clippings" showing the data in use, whether from the print media, radio or television, further reinforcing to respondents the use and importance of their reporting efforts. This will significantly reduce the labor-intensive overhead associated with our information dissemination activities while providing improved services to users.

1.3 The Current Employment Statistics Program

The CES is an ongoing monthly survey of about 390,000 non-agricultural establishments. The CES preliminary estimates, released on the first Friday of each month, receive vast media coverage, are considered among the most influential data series for economic policy purposes, and are a driving force behind the financial markets. The CES is well suited for CASIC methods because it has a very short collection period (between 2 to 2.5 weeks) and collects a small number (5 or 6) of numeric, commonly available payroll-related data items. Since 1982, the CES staff has researched and implemented CATI, CAPI, TDE, VR and EDI for traditional mail collection. At the end of 1996, over 220,000 respondents reported monthly using TDE with thousands more in transition. Some of the largest multi-unit companies report through EDI.

1.4 ES-202 Employment and Wages Program

The ES-202 program is a by-product of the Unemployment Insurance (UI) system in each state. Each quarter, all businesses with employees covered by the UI system must report to the respective state information including the number of employees for each month and total quarterly payroll. These reports provide the basis for a universe list of covered businesses. Covering over 97% of total US employment and 7.8 million establishments, the ES-202 program serves several roles. It is the universe list for sampling for BLS business surveys and also provides the annual employment benchmark. It also provides the most timely and complete economic data for counties for each quarter.

Both of these programs have opportunities to reduce cost and respondent burden through the most modern collection techniques. Both programs are very large, offering sufficient numbers of respondents in categories suitable for multi-mode collection while still being cost-effective. Smaller surveys may have difficulty developing and maintaining multi-mode collection systems.

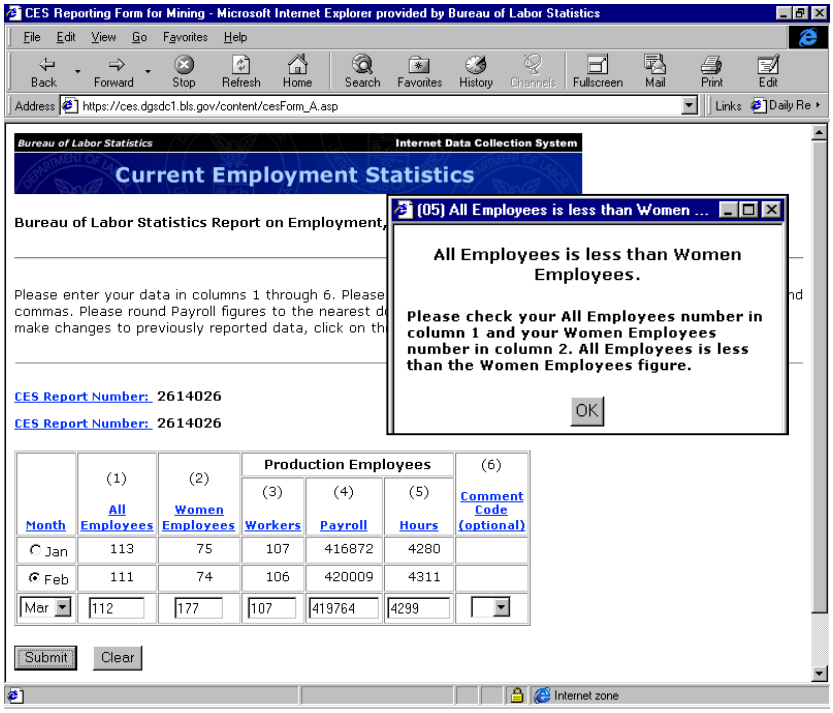
2. WWW METHODOLOGY

Developing a WWW survey methodology involves using tools developed under two other methods. These tools include the respondent contact procedures analogous to those used in TDE, and the automated self-interviewing techniques familiar from CSAQ. The combination of these features comprises the likely direction of WWW collection methodology.

All BLS WWW respondents must obtain a digital certificate before they can report data on-line. Digital certificates authenticate the respondent's identity to BLS and ensure the identity of BLS to the respondent. Once a digital certificate has been obtained, the Current Employment Statistics (CES) WWW survey methodology begins with a sample control file containing the respondent's E-mail address in addition to the normal respondent contact information of name, address, and phone number. As the collection cycle begins, the respondent opens his or her E-mail to find an advance notice reminder, paralleling the advance notice postcards and faxes now sent to over 220,000 TDE respondents. When respondents are ready to report, they point their browser to the survey homepage, access

the data collection screen, and fill in the requested data. The collection form is a standard "web page" containing an image of the questionnaire, survey instructions, definitions, and hypertext links to definitions. An E-mail address is provided for problem reporting and inquiries. The moment the respondent clicks the "Submit" button, the data are automatically edited, and edit failures are noted on the screen (see Figure 1). The interactive edits ensure numeric data entry and check for any breaks in logic (such as an All Employee value less than the number of Women Employees). Clean data are transmitted to BLS.

Figure 1. CES Collection Screen with Edit Note



The collection system electronically checks in the schedules, and at predetermined time periods, sends E-mail nonresponse reminder messages to delinquent respondents. Finally, a "Last Chance" non-response E-mail prompt is sent to delinquent respondents on the morning of the monthly deadline. This message is usually more urgent in tone than the previous messages, and requests respondents to report immediately if their data are ready. Under Web methodology, most survey data collection operations can be fully automated and the overall process simplified for both the survey agency and the respondent.

2.1 Automated Self-Response Contact Methods

The CES is an ongoing survey for which establishments report data every month, most for at least a few years. Traditionally, mail surveys relied on the arrival of the form to spur the respondent's reply. If a response was not received by a certain time, a nonresponse prompt was issued. Often, nonresponse prompts were wasted as there was no knowledge about whether or not the forms were in transit.

Under WWW, the entire methodology can be automated, from the timing and content of the E-mail messages to firm-specific nonresponse prompts based on the known availability of needed records. With all data entered and edited on-line, and most or all messages handled automatically by E-mail, a truly "peopleless-paperless" methodology is possible (see Werking, 1994). WWW methods can be viewed as very similar to or an extension of CSAQ, with the added benefits of instant receipt of data, central updating of the instrument, and the elimination of costly mailing or lengthy downloading of large instruments.

2.2 CES WWW Instrument Design Issues

The WWW poses some difficult issues for designers. Maintenance of security, accounting for transmissions and interface design are key issues. Federal surveys are required to maintain strict confidentiality about participants and their data, thereby adding requirements for encryption.

Security played a major role in the development of the CES WWW collection system. Security and confidentiality requirements shaped the login process used to access the CES system. The implementation of digital certificates means respondents don't enter a password or PIN to access the system. Instead, the digital certificate authenticates the respondent's identity. Secure Sockets Layer (SSL) Protocol, an industry standard for encryption, ensures a secure connection and secure transmission of data.

Security requirements also affected, to some extent, the interface design of the CES WWW system. Once a respondent has been authenticated as a legitimate CES reporter, there is no need to enter an identification number, or report number, to report for each location. Instead, information contained in the digital certificate helps identify the report number or numbers associated with the respondent. Respondents simply choose the report number for which they wish to report from a drop-down box which contains only report numbers for which they are responsible. This eliminates the possibility of error or fraud. It prohibits, for example, Company A from logging into the CES WWW collection system as Company B and obtaining confidential information about or reporting for Company B.

There are some interface design issues that are independent of security or confidentiality concerns. Scrolling versus "pages" is the first of these issues. Many WWW sites use scrolling capability, but these are mostly text-based sites. However, the page-based design offers benefits for survey management. Research comparing both scroll and multiple page-based design indicate that the page approach offers the advantage of capturing important interview information, such as time spent on each screen, and does not increase total session time and overall completion rates (see Vehovar and Batagelj, 1996). The page-based design also facilitates the use of branching, a feature routinely implemented in computer assisted surveys.

CES chose the "page-based" approach in order to limit the amount of scrolling required of the respondent. In making this choice, however, the respondent's ability to navigate knowledgeably within and among screens was also considered. A key to user satisfaction, the screen design must make it clear to the respondent how to move about within the questionnaire. The use of white space aids in this design, as does the use of well-labeled buttons and very specific hyperlinks. Familiar browser tools for "back" or "forward", or buttons with similar functionality, allow the user to move within the instrument and should be integrated to make such movement easy.

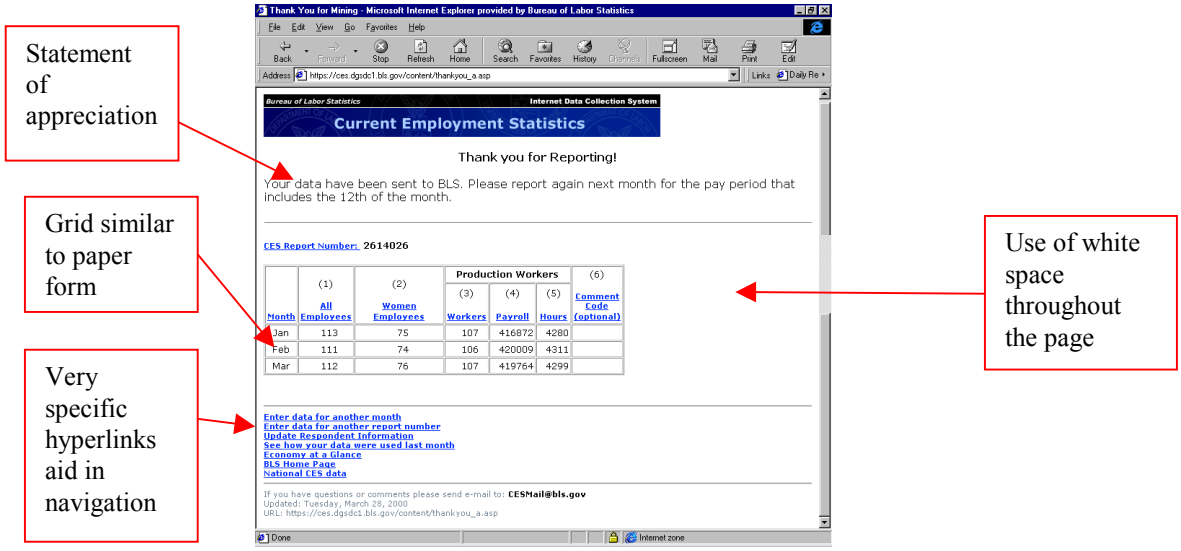
CES incorporated these basics of interface design when developing the interface for the WWW collection system. CES had four main goals when developing the interface: (1) Keep the interface simple and intuitive; (2) Make the on-line form resemble the paper form; (3) Provide the ability to navigate logically through the system; and (4) Provide feedback and positive reinforcement to the respondent.

Figure 2 shows how these fundamentals were implemented. The use of white space throughout the page makes it visually appealing and easy to read. The amount of scrolling is limited because of a "page-based" design. The grid used to present previously reported data is the same type of grid layout used on the paper form, which is familiar to the respondent. Feedback is provided at the top of the screen in the form of a statement of appreciation that acknowledges the successful submission of data. And very specific hyperlinks at the bottom of the page enable the respondent to navigate logically through the system.

Other features of the CES WWW collection system include:

- The use of drop-down boxes and radio buttons where possible. This point-and-click method reduces the number of items the respondent must input.
- The presentation of up to three months of previously reported data.
- An expansion of the on-line edits. At this writing, edits are being expanded to include longitudinal checks for large over-the-month changes in data.

Figure 2. CES Thank You Page



3. RESULTS

Beginning in March 1996, the CES launched a live pilot test of WWW collection for approximately 100 respondents. These respondents were formerly reporting via TDE or CATI and were familiar with the monthly reporting cycle. The CES pilot approach was designed to build basic functions and to allow testing of important methodological features, rather than as an attempt to complete a production system while hardware and software rapidly evolve.

The WWW pilot test results mirrored lengthy prior TDE research. This approach yielded two critically important results. First, the basic response rates for our time-critical preliminary estimates for these units are essentially the same under WWW collection, 76 percent, as under TDE, 78 percent. Thus, we see no reason at this early juncture why WWW collection will not be able to match the same high response rates seen under similar telephone-based methods, TDE and VR. Second, E-mail messages seem to be as effective as other prompting methods. The proportion of WWW units needing E-mail nonresponse prompts, 35 percent, is nearly the same for the overall TDE sample. This means that respondents can receive the advance notice messages through a variety of E-mail systems, they access their E-mail regularly enough for a time-critical monthly survey, and they respond to E-mail messages.

Based on this finding, more elaborate tests and refinements in message methodology, including the packaging of the E-mails with such features as voice files, graphics, or icon links to the Web site, will be formally tested for user ease and acceptance. Preliminary research suggests that this technology must evolve more before we can expect to use these features on a regular basis. Small, informal tests have been performed on the compatibility of E-mail systems between BLS and the outside world. The results of these tests revealed that most attachments, graphics, and rich text were not received as expected. The graphics were not viewable by the recipient, and the rich text format (such as bold text, different color text, and different size font) didn't always appear to the recipient as was intended. Nevertheless, new software products which support HTML format E-mail will significantly ease the burden of sending enhanced E-mail messages.

The CES test pilot offered other interesting results:

- Excluding submissions that failed the edit checks, the average length of a WWW session takes about two minutes. This is only eight seconds longer than a TDE interview.
- On-line edits have resulted in the delivery of clean data. Approximately 3% of all web reports fail at least one edit check each month, which is basically the same failure rate we see for TDE data. However, the data collected via WWW is edited before submission, whereas TDE records that fail must be followed up with analysis and possibly a phone call to the respondent. One encouraging result from the on-line editing is that in

88% all WWW edit failures, the respondent is able to correct and re-submit their data during the same session. The remaining 12% were able to log-on at a different time, usually a day or two later, and successfully re-submit their data. The most common edit failure for CES WWW reporting is the entry of non-numeric data (38% of all failures).

4. WWW IMPLEMENTATION ISSUES

Aside from the direct benefit of obtaining timely and accurate data, CASIC methods offer implementation opportunities to survey institutions, such as reduced costs, and some challenges, such as potentially profound organizational effects. Also, the WWW demands security for the transmission and storage of information, and confidentiality of our respondents where law and institutions have yet to fully provide an umbrella for operations as exist for other electronic transmissions.

Without including the labor savings, WWW operates at one-fifth the cost of mail collection. Also, the WWW costs are not linear; the capacity included in this estimate for WWW could likely handle twice this workload without a significant increase in costs, depending on the level of security implemented in the system. For all but the smallest surveys, the growing disparity between postage and telephone costs will drive recurring surveys to automated self-response CASIC as transmission and hardware savings far exceed systems development and maintenance costs.

The drive for cost reductions at equal or higher quality is a constant force in any production function. Cost savings can be either redirected towards larger sample size or other quality-enhancing activities, or used to satisfy overall constraints of lower resource levels to prevent quality compromises. The large scale implementation of WWW collection will result in the flow of clean, edited data directly to the survey organization. Thus, both labor and non-labor resources will be shifted among the remaining and new factors of production. The most obvious result is that post-collection data review and entry are virtually eliminated. The emphasis shifts instead towards computer systems development, and the maintenance and operation of the new collection process.

The view of WWW collection as a "peopleless, paperless" methodology (Werking, 1994) has profound implications for survey organizations. The fully integrated WWW design using automated, outbound E-mail messaging and on-line entry and editing leaves virtually no role for clerical or professional interviewers.

Security concerns have hindered more rapid exploitation of WWW collection. However, recent advances in encryption techniques and other systems features point to an upcoming rapid expansion of the pent up demand for these tools. Within BLS, at least three other survey programs besides the CES Program are developing WWW-based collection, including the ES-202 program, the Producer Price Index, and International Prices. Nevertheless, respondent acceptance of digital certificates will be a challenge for all BLS WWW surveys in the near future.

5. ELECTRONIC DATA INTERCHANGE (EDI)

EDI, as used in BLS, is the transmission of data electronically from a respondent to BLS. Standard formats are developed and the respondent firms translate their firm's files into this format. Once the translation software is developed, the recurring data files can be provided to the survey agency quickly, accurately and at low burden. Thus EDI can dramatically reduce ongoing respondent burden, particularly for the largest, multi-establishment firms, those which inevitably are chosen as certainty units in all surveys. On February 22, 1995, BLS opened an Electronic Data Interchange (EDI) Collection Center in Chicago, Illinois. This center was initially created to facilitate the collection of data for the CES survey in a timely and cost-efficient manner but was later expanded to include establishment data for the Covered Employment and Wages (CEW) program.

5.1 Multiple Worksite Report (MWR)

As a part of the CEW program, the Multiple Worksite Report (MWR) is collected each quarter to disaggregate the employment and wages of numerous establishments owned by an employer that are reporting under the same Unemployment Insurance (UI) account number in a State. The summary information for this employer is reported on the State's Quarterly Contribution Report (QCR). Also collected are the physical location address of each worksite; a reporting unit description (normally a store or unit number or other information meaningful only to the employer); and various other business identification information. These two reports are the major components of the CEW Program. Since UI coverage is virtually 100 percent in all industries, the employment and wages from this

program represent a census of the Nation's employment and wages each quarter. The establishment micro level data submitted by the States from this program contain the employment, names, addresses, other business identification information, Standard Industrial Classification code, geographical code, etc. for each establishment. These data are the major component of the Bureau's business registry.

The EDI Collection Center opened two new doors of opportunity for firms. First, the EDI Collection Center offers large multi-State firms the option to transmit their data for all States to one facility rather than potentially fifty different sites. The EDI Collection Center then edits and distributes these data to the respective States. The responses to this new reporting option have been very enthusiastic. The second opportunity is the ability to transmit these data electronically, rather than using a magnetic medium-tapes, cartridges, or diskettes. The use of magnetic media requires a disposal or return of confidential information that increases the processing costs for the employer and BLS. Both of these points result in a reduction in the burden on the part of the employer. The employer no longer has to receive the MWR forms each quarter, prepare the information that would be manually posted on the MWR forms, and then mail the appropriate information to the different States.

Firms incur some start-up costs to evaluate the changes required to their system and to write the programs needed to create the electronic file to meet BLS requirements. Included in these costs are those associated with testing the system and the overlap test period where the company is required to submit both the paper MWRs and the electronic file. The EDI Collection Center estimates that it takes an employer an average of six to nine months from the time that the initial solicitation contact is made before an employer provides a test file to review. The process usually involves the preparation of a cost proposal by the payroll department and the systems' staff, which is then reviewed by higher level management to determine its cost/benefit ratio. If the project is approved, it is usually assigned a low priority relative to the programming updates that are needed to address modifications to State and Federal tax laws.

The experience of the EDI Collection Center staff is that it takes several test files before an acceptable file is approved. On average, it takes three test files to obtain a "good" file. The reasons vary by firm but are a function of those items mentioned above. Additional delays may also occur if an approved test file does not fall in sync with the overlap test period. For CES data, an overlap of three months is required while for the MWR data, an overlap of two quarters is required. For instance, if a test file is not approved until after an MWR has been submitted for the current quarter, the firm will need to wait until the following quarter to begin the overlap period.

The start-up costs involved in implementing EDI have been cited as being potentially very high by some firms and often noted as the reason for their non-participation. Other firms have responded that a lack of staff time available to perform this work as the reason for non-participation. Most of their available programming staff resources are spent maintaining the systems to reflect the constant State and Federal tax law revisions that were mentioned earlier. For these reasons, the MWR staff decided that a more effective approach to having firms utilize the EDI Collection Center was to have the Payroll Provider Firms (PPF) and the Payroll/Tax Software Developer Firms (PSDFs) install the required software in their systems for the use of their clients. This action would reduce the number of firms that potentially would have to incur the start-up costs.

5.2 Survey of the Payroll Industry

The view cited above received a significant boost in 1993 with the findings from a report that was conducted by BLS staff to determine the reasons for a divergence in the employment series between the monthly CES and the quarterly CEW programs between December 1990 and January 1991. That study enumerated the extensive degree to which firms either use a PPF or use a mainframe computer payroll/tax software system that is either purchased or leased from a PSDFF. The study estimated that firms that utilized the services or software of PPFs or PSDFs covered approximately thirty-five million employees. Those firms that perform payroll activities themselves can be divided into two groups, those who purchase their software and those that have developed their own "in-house" payroll/tax software.

To summarize, the report categorized firms into three main groups:

1) those who utilize the services of a PPF;
2) those who purchase their payroll/tax software from a PSDF; and,
3) those who have developed and maintain their own "in-house" payroll/tax software.

5.3 Participation in Payroll Conferences

Since 1991 BLS staff have been attending the annual conferences of two payroll associations. The American Society for Payroll Management (ASPM), which has approximately 500 members, first invited BLS to speak at their 1991 conference to explain the new MWR form and its impact on the members of their association. This association is composed mainly of the upper level management of the payroll and tax operations of very large companies. Their members are typically from Fortune 500 companies. It is an excellent forum to discuss new program initiatives that affect their members. At the 1992 conference when the magnetic medium specifications were first released, the transmittal of these statistical data to the States was received politely but with minimal interest by firms. The same reaction occurred at conferences sponsored by the American Payroll Association (APA), which has 15,000 members. BLS staff began attending these conferences in 1993.

At both of these conferences, BLS staff is provided with a booth in an exhibit hall to distribute materials to attendees and also answer their questions on related issues. Most of the attendees visit the exhibit hall since many of the private sector vendors entice members by holding drawings for prizes for those who have visited their booth. Another valuable by-product of participating in the exhibit hall is the opportunity to provide the PPFs and PSDFs, as well as the attendees, with various materials (magnetic media specifications booklet) and also pick-up brochures on the principal products or services that the vendors provide.

This procedure also has enormous cost savings potential for the States and ultimately for BLS for the reasons listed below:

1) Less postage required for mailing the MWR forms to firms and its subsequent return;
2) Less staff required to process the MWR forms (opening the mail, sorting the forms, etc.);
3) Less data entry of the MWRs; and,
4) Reduction in the errors caused by posting errors by the employer or data entry errors by the State.

For those firms using a PPF, the PPF would offer the filing of the MWR data for all the appropriate States electronically to the EDI Collection Center as one of their services that they provide for their clients. The client would usually pay a fee to the PPF for this service. For those firms that use the software of a PSDF, the PSDF would incorporate the necessary software in their system that the clients use. The client would then be able to utilize the electronic transmittal to the EDI Collection Center with minimal start-up costs since the PSDF had absorbed these costs in providing this additional feature to their payroll/tax system.

While this strategy seemed rather straightforward, it was predicated on the assumption that the PPFs and PSDFs would want to add this feature to their payroll/tax systems for their client's benefit. In 1991, firms providing these payroll services or software for lease were slow to react to the introduction of the new MWR form. It was only when their clients started to indicate a need for their systems to address collecting and storing employment and wages data by worksite did these companies react. In the subsequent nine years of continuous work with PPFs and PSDF's, a growing number have included this feature in their software. At this writing, one PPF and eight PSWD's are actually outputting MWR data. Another three firms providing PPF services are completing their required test phase and three additional PSDFs are in the design stage.

5.4 Publicize the EDI Collection Center in Payroll Newsletters

These organizations have also allowed BLS to place articles in their payroll/tax advisory newsletters and or manuals. These firms have been instrumental in helping BLS disseminate information on the central reporting of MWR data to the EDI Collection Center in Chicago. This same approach is also a key factor in BLS' efforts to have the PPFs and PSDFs include the electronic submittal in their systems. At the present time, two PPFs and five PSDFs have told BLS and their clients that they intend to add this feature to their system during the next 18 months. Other PSDFs have expressed an interest but have not committed to its inclusion. This list will also be provided to the firms providing the payroll/tax advisory newsletters mentioned earlier for inclusion in their publications. It is BLS' hope that when a company is selecting a PPF or PSDF that they review all of the services/capabilities of the firm's software.

5.5 Status of EDI

ES-202:	Currently reporting to the EDI Collection Center
Number of Firms	49
Number of Legal Entities	6,300
Number of Establishments	70,665
Employment	4.47 million

CES:	
Number of Firms	22
Number of Establishments	22, 950
Employment	2.54 Million

5.6 Improving Data Quality

The conversion process is used to identify and correct data quality problems. The effect on the conversion process, as well as BLS data, can be significant. Several data quality issues have been addressed with firms currently reporting to the EDI Collection Center. Examples of these are: 1) Corrected employment counts where all active employees for the entire month were previously reported, including employees who did not work during the pay period which includes the 12th of the month. 2) Corrected employment counts and wages where previously reported data were derived from secondary sources. 3) Reporting employment, hours, and earnings for non-supervisory employees which were not previously reported. 4) Previously erroneously included employees who were in an active status but did not receive pay for the pay period which includes the 12th of the month. 5) Previously reporting data at countywide level rather than at worksite level. 6) Previously reporting all employees and non-supervisory employees as the same figure for the CES program.

6. REDUCTION IN RESPONSE BURDEN

The EDI Collection Center has been able to analyze the reduction in respondent burden by working with selected firms. One firm reduced their reporting burden from 40 to 4 hours per month whereas another dropped from 6.5 to .5 hours per month and a third fell from 4 to .5 hours per month. Other firms have experienced similar reductions once electronic conversion was completed. The reductions are affected by the data processing costs and the firm's internal organization as described above. Firms have noted that they have experienced a reduction of respondent burden in another way: less contact from BLS to obtain data or resolve data questions. Previously, firms may have had up to fifty different contacts about the availability of the data or questions on these data from the states. Those contacts have now been reduced to one - the EDI Collection Center. This was an initial policy decision that has proven to be effective in persuading employers to adopt centralized electronic reporting.

In conclusion, BLS staff is developing a multi-faceted approach to having large firms report electronically for several of its statistical reports to the EDI Collection Center. This approach should reduce their reporting burden and increase the quality of the data on the Bureau's Business Establishment List while lowering overall program costs. BLS attendance at payroll conferences has helped to disseminate the availability of this new reporting option to firms, service bureaus and the developers of payroll/tax software. The class instruction and the booth in the Exhibit Hall provide an excellent forum to discuss these developments directly with the participants. The initial incorporation of the electronic reporting requirements into the systems of some PPFs and PSDFs will hopefully lead to its inclusion by most of these firms as they strive to remain competitive in the features that their systems provide.

7. THE FUTURE FOR EDI

To date, the concept of centralized electronic collection of CES and MWR data appears to be viable and valuable. Response burden can be reduced, timing maintained, and data quality improved. Firms are definitely pleased to be offered an alternative data collection method. The standardization of the format has been much appreciated by firms and remains a selling point. Interest among the respondents who provide the data is high, but this must be weighed against the data processing resources available to accomplish the task. The potential number of firms reporting that may develop as PPF's and PSDF's add this feature to their systems makes the concept of centralized electronic reporting even more attractive.

8. THE FUTURE OF TECHNOLOGY IN DATA COLLECTION

The rapid and continuing evolution of technology will continue to reshape survey methods. WWW and EDI methods target different respondent populations with the purpose of reducing costs, improving quality and timeliness. EDI in particular reduces ongoing respondent burden.

These technologies can be combined in the future to reduce respondent burden even more. EDI over the Internet combines the ease of reporting from EDI with the edit capabilities of the Web into one method that would increase the quality of the data while minimizing respondent and survey staff intervention. Establishment's systems could be programmed to create the data file and automatically submit it using File Transfer Protocol (FTP). Once the data file was received by the survey organization, it would be automatically edited, and any records failing edit would be flagged with the edit failure reason and sent back to the establishment for review using FTP. Clean data would be automatically loaded in the survey organization's main data stream. Manual intervention would be needed by the respondent only if edit failures were returned. The major drawback of this method begins with security. Organizations would be faced with the same security issues as they are with WWW collection.

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COSTS AND ERRORS OF WEB SURVEYS IN ESTABLISHMENT SURVEYS

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ABSTRACT

Surveys performed on the Web are extremely cost-attractive and they are becoming an increasingly important mode of data collection. However, problems with sampling frames, lack of technical support for the person eligible to answer in an establishment survey, and specific non-response patterns, make this mode extremely problematic. The following paper overviews the state of the Web survey methodology, the prospective and, in particular, the issues related to costs and (sampling, nonsampling) errors in these surveys. The empirical study performed among 3000 Slovenian establishments showed relatively favorable results for the Web survey mode.

Key Words: Web surveys, Internet surveys, survey costs, non-response, mean square error, total survey error

1. INTRODUCTION

In survey research, we often discuss various procedures for improving quality of data but rather rarely we discuss survey costs. However, only an optimum balance between the errors and the costs makes methods for improving the quality practically useful. This is particularly important with new and inexpensive modes of electronic data collection, such as Web surveys[1]. They are often praised as the cheapest data collection mode (Clayton and Werking 1998; Farmer 1998; Spaeth 1999; Watt 1997), but also criticized as the mode that is characterized with low quality and non-valid results. The cost-error issues are thus becoming much more radical topic with this new survey mode.

In this paper we first present general costs-errors issues in Web surveys for establishment research. The bulk of the paper is then dedicated to experiments that were conducted during the 1999 survey on Internet and IC technologies in Slovenia. A study among 3000 establishments empirically evaluated costs and errors of telephone, mail, fax, and Web survey mode.

2. COSTS AND ERRORS IN WEB SURVEYS

Web surveys are well known for extremely low costs in comparison to other survey modes. Compared to mail surveys there are no costs for paper, printing, envelopes, stamps and related administrative work. Compared to telephone or face-to-face surveys additional reduction arises from absence of interviewer costs. Compared to telephone surveys only, Web surveys eliminate telephone line connect-time charges. And of course, in comparison to all paper-and-pencil questionnaires, regardless of the mode, there are no costs for data entry and editing. It is true that moderate start-up costs for equipment, Web page design and testing are needed (Onyshkevych and McIndoe 1999), however costs per interview quickly decrease with number of questionnaires completed (Clayton and Werking 1998; Onyshkevych and McIndoe 1999; Watt 1997).

The low costs enable large samples, which decrease the sample variance. However this is not enough to assure the quality of survey data. The most frequent limitation of Web surveys is the frame deficiency because not all target units have access to the Web. Fortunately, due to higher Internet penetration in establishment surveys this problem is usually less severe than in household surveys. We can illustrate this with data from Slovenia at the beginning of the year 2000. Slovenia is in this aspect a typical European country, with 25% of active population using the Internet, however with 65% (of the smallest) to 95% (of the large) companies accessing the Internet (RIS 1996-2000). Nevertheless, establishment units with no access may still be different from establishment units with the access. In

[1] Here, with Web survey mode we understand a computer-assisted self-administered survey (without the presence of an interviewer) where a computer questionnaire, based on HTML, is presented in a standard Web browser, and the responses are transferred to the server through the Internet (Vehovar, et al 1999).

addition, the within establishment access may create additional problems. The research in Slovenia shows that, among the companies with the Internet access, percentage of employees who actually have access to the Internet varies from 30% in large to 90% in the smallest companies (RIS 1996-2000).

Another problem is the unit non-response. Unit response rates in noncommercial establishment surveys with 'traditional' data collection procedures can be as low as 28%, but also as high as 100% (Christianson and Tortora 1995; IGEN 1998; Paxson, et al 1995; Tomaskovic-Devey, et al 1994). Different factors influence response rates in establishment surveys and one of them is also the self-administration. In self-administered surveys, therefore also in Web surveys, absence of an interviewer and less intensive contacts with respondents usually result in lower response rates (Baker 1998; Christianson and Tortora 1995).

Above limitations aside, certain features of Web surveys increase data quality. If properly designed and programmed, Web surveys support all advantages of computer assisted survey information collection (Clayton and Werking 1998; Spaeth 1999). In addition, they may offer the possibility for businesses to transfer data directly from their electronic files and in this way aid the respondents in completing their task with efficiency and accuracy.

Of course, unobserved data collection is one of the problems with Web surveys as respondents are neither observed nor prompted while responding a questionnaire (Farmer 1998). In addition fictitious data, multiple responses, item missing data and misunderstandings (because of the absence of the interviewer who could give additional explanation) can deteriorate the quality of survey data (Baker 1998).

3. EMPIRICAL STUDY: RIS 99

The research problem of errors and costs is discussed empirically on an establishment survey of Slovenian companies. This multi-mode survey on the use of Internet and information-communication technologies was conducted as a part of a larger research project *Research on Internet in Slovenia - RIS* at the Faculty of Social Sciences, University of Ljubljana (http://www.ris.org). Different modes of solicitation (telephone, mail, email) and different modes of interviewing (telephone, mail, fax, Web) were used. Errors and costs were compared across all cells of experimental design following the key research question: which mode produces the optimum balance, e.g. the lowest error and the lowest costs. We are especially interested if Web surveys can become an alternative to telephone or mail data collection modes which are predominantly used for establishment research (Christianson and Tortora 1995; Nicholls II, et al 2000).

The experiment was performed on a representative sample of SMEs (5-250 employees) in Slovenia. The data collection was performed in November – December 1999. Sampled units (companies) were randomly assigned to six experimental groups which differed in mode of solicitation and mode of interviewing (Tables 3.1., 3.2.). Computer assisted telephone interviewing (CATI) with at least 10 follow-up calls in the case of non-interview was used for group A. Mail invitation was used for groups B, C, and D, however different modes of interviewing were used:

- group B: units were invited to answer a paper questionnaire and return it through mail,
- group C: units were invited to answer a paper questionnaire and return it through fax,
- group D: units were invited to answer a questionnaire on the Web.

In all three cases two follow-up letters were used (the first follow-up one week after and the second follow-up three weeks after the first letter). For groups B and C a supplement questionnaire was added in the second follow-up.

Invitation to the survey on the Web sent through email was used for group E and they responded to a Web questionnaire. Also in this case two follow-up messages were sent, however in shorter time periods (the first message was send on Monday, the first follow-up on Thursday, the second follow-up again on Monday, therefore one week after the first message).

Group F received an invitation through mail, however they were given a possibility to choose a mode of interviewing: a paper questionnaire and returned it through mail (F1) or fax (F2) or a Web questionnaire (F3). Two follow-ups with supplement questionnaire in the second follow-up as for groups B and C were used. This group is used for studying the respondents' preference of the interviewing mode and it is not included in comparisons of errors and costs since this would not be an usual survey design.

	Interview →			
Solicitation ↓	*Phone*	*Mail*	*Fax*	*Web*
Phone	Group A (900)	-	-	-
Mail	-	Group B (300)	Group C (100)	Group D (300)
Email	-	-	-	Group E (200)

Table 3.1. Experimental groups A-E (sample sizes in brackets)

	Interview →			
Solicitation ↓	*Phone*	*Mail*	*Fax*	*Web*
Mail	-	Group F1	Group F2	Group F3

Table 3.2. Experimental group F (n=300) with self-selected options for completing the questionnaire

Table 3.1. presents initial sample sizes for the experimental groups. In group E only 41 email addresses from public email directories or by surfing the Web were found (out of 200). Therefore email invitation was sent only to these companies. When calculating errors and costs for each group the initial sample sizes were adapted in order to enable the comparisons. In all groups the initial sample size was set to 300 units. Also for the group E exactly 300 units with known email addresses were assumed.

The telephone interview lasted for 3 minutes[2], the paper questionnaire was printed on two pages and the Web questionnaire had six computer screens (due to automated skips), however same questions were asked in all three modes. Person intended to answer the questionnaire was the company's directory or person responsible for IT/Internet within the company. However, name of this person was not known from the sample frame and we had to rely on the communication system within the organization in order to contact the intended reporter. For paper and Web questionnaire identification of respondents was provided in order to use the follow-ups only for non-respondents. There was an identification number printed on the paper questionnaire. Companies invited to answer the Web questionnaire received an identification number in the advance letter (and in the follow-ups) and had to enter it at the first questionnaire page on the Web in order to access the survey.

3.1. Research hypothesis

H1: Costs of data collection decrease from group A to group E.
Telephone surveys are in general more expensive then self-administered surveys and paper self-administered surveys are in general more expensive then self-administered surveys on the Web. In our case, costs that are included in the calculations of the overall costs are the costs depending on the mode of solicitation, mode of interviewing and mode used for returning the paper questionnaires. Costs for the design of the questionnaire for different modes are not included because software that supports Integrated Computer-Assisted Data Collection (ICDC) (resulting in easy transformation of the questionnaire to the surveys of different modes) (Vehovar and Batagelj 1996) was used. That means that costs for questionnaire design were the same for all modes. In such a situation, for example, mail solicitation is more expensive than email solicitation, interviewing on the phone is more expensive than distributing paper questionnaire which is more expensive than having a questionnaire on the Web, mail for returning questionnaires is more expensive than fax, etc. Given this, the costs of data collection are expected to decrease from group A to group E.

H2: Survey errors increase from group A to group E.
Survey error measured as the sum of variance and bias (Section 3.2.) increases with lower response rate. Namely, lower response rate results in smaller sample (larger variance) and larger possibility of difference among the true and the sample value of the target variable (larger bias). In our case, the difference among experimental designs, which may affect the response rates, lies in the intensity of invitations to participate in the survey and methods of nonresponse conversion. The telephone call from an interviewer is much more intensive than a letter received by mail or email. And we expect that a mail letter with paper questionnaire is more intensive than a mail letter or an email message with the URL address of the Web questionnaire. Therefore we expect response rate to decrease from group A to group E and parallel survey error to increase from group A to group E.

[2] The actual telephone interviews were longer, because in addition to questions which were included also in the paper and the Web questionnaire, there were other questions asked to respondents on the telephone. If only questions included in the experiment were asked, the telephone interviews would last 3 minutes.

3.2. Data analysis: optimization

Errors. The components of survey errors have already been well elaborated (Groves 1989). In this paper we limit ourselves to the sampling error and to the component that belongs to the nonresponse bias. We use the standard form of the mean square error (Kish 1965). We assume a simple random sample (SRS). We further assume that we are dealing with a simple population parameter - the population percentage P or the population mean of a continuous variable y. In our specific example the root mean square error (RMSE) is then based on the sum of variance and squared bias:

$$RMSE(p) = \sqrt{MSE(p)} = \sqrt{Var(p) + Bias(p)^2} .$$

We have an estimate of RMSE(p) for a population percentage P or a continuous variable y:

$$rmse(p) = \sqrt{\frac{p(1-p)}{n} + (P-p)^2} \quad \text{or} \quad rmse\left(\bar{y}\right) = \sqrt{\frac{s^2(y)}{n} + \left(\bar{Y} - \bar{y}\right)^2} ,$$

where the finite population correction was omitted.

The above-defined RMSE is calculated for all variables for all experimental groups. Since the true population value is unknown we assumed that the true value is the value achieved from the telephone survey with at least 10 follow-up calls for nonrespondents. We assume that the difference among the true population value and the value obtained from the telephone survey is the smallest. Namely, the achieved response rate in the telephone survey was the highest (63%, Section 4.1.) and the presence of an interviewer most likely assured that errors in responses due to misunderstandings, lack of interest, etc. were minimized. In addition, since we want to elaborate whether Web surveys can be used as a valid alternative to telephone surveys, the 'true' value can be regarded as the value obtained from the telephone survey which would usually be used in such case.

Costs. In traditional cost model total costs are the sum of fixed and variable costs (Groves 1989). In our case, only the variable costs (costs for mailings, emails, telephone charges, data management and data entry) which vary with the sample size were included in the calculations. They are different for different experimental groups (for example a paper questionnaire is needed for group B and C, but not for other groups) and some of the items are not always needed (for example, there are no special costs for data entry in group D).

In order to simplify the calculations, the costs of searching the email addresses for the group E were not included. The calculations are performed as if email address was known from the sample frame for all the units in the initial sample.

Optimization. The sampling error stems from measuring only a subset of the population, a sample (Groves 1989). A solution for the sampling error is enlarging the sample size and with this minimizing the variance (and therefore the probability that the subset will significantly differ from the population). However, sample size is usually limited by the survey budget. In addition, even with a larger sample size, at a certain point the sample variance does not change any more and therefore can not diminish the total survey error, especially if other survey errors contribute to the total error. Therefore efforts should be made also to diminish the possibility of nonsampling errors. One way is to choose a survey design, which leads to the lowest nonresponse. That contributes to the decrease in survey error in two ways. First, larger response again leads to larger sample size and therefore smaller variance. In addition, efforts for nonresponse conversion decrease the possibility that nonrespondents are significantly different from respondents, therefore decrease the bias.

In practice, an optimum balance between costs and errors is needed. In general, optimal design may be stated in two alternative ways: achieving minimum RMSE for fixed costs, or achieving minimum costs for fixed RMSE. Both principles would generally lead to the same solution (Kish 1965). In this paper, we concentrate on the optimization of the RMSE for fixed costs. It is possible to decrease the sampling error with larger initial sample and simultaneously increase the nonresponse error with a different solicitation/survey mode, or the other way around, but keeping the costs constant. For example, we can compare the RMSE for a Web survey with a large initial sample and email solicitation with a Web survey with smaller initial sample and mail solicitation, while keeping the costs constant. In the paper, we present such possible alternative designs at fixed budget.

4. RESULTS

4.1. Unit response rates

Different factors influence unit response rates in establishment surveys in general: characteristics of survey sponsor, mandatory status of the data request, size of firm, respondent selection, follow-up activities, salience of topic, mode, availability of requested data, survey design, length of data collection period, etc. (Paxson, et al 1995; Rosen, et al 1999; Willimack, et al 1999). In our case, we can explain the differences in response rates by mode of solicitation and mode of interviewing that were used.

In table 4.1. two measures of response are presented. (1) *Completion rate* is calculated as a number of respondents among all sent mail or email invitations (groups B to E) or at least once called units (group A). Uneligible units are also included into these calculations since costs include also these units. However, since we compare the Web survey mode to other modes, we are actually interested only in respondents who have access to the Internet. Therefore (2) *final response rate* as the function of completion rate and of share of companies having access to the Internet is also calculated.

Group	Completion rate	% having access to the Internet	Final response rate = having access to the Internet/initial sample size
A (phone-phone)	63%	83%	52%
B (mail-mail)	54%	74%	39%
C (mail-fax) [3]	43%	76%	32%
D (mail-Web)	32% (26%)	100%	26%
E (email-Web)	32% (7%)	100%	7% (27%)

Table 4.1. Response for experimental groups

Groups D and E need special consideration. In group D only companies having access to the Internet were able to answer (in the advance letter, companies not having access to the Internet were asked to ignore the invitation). The actual completion rate for group D was 26% (responses present 26% of all units assigned to this experimental group). However, assuming that 83% of units in this group have access to the Internet (as it resulted from the telephone survey), the completion rate for companies with the Internet access is therefore 32% (0.26/0.83).

In group E only those having access and known email address were able to answer. In our case, the email address was found in the public email directories for 21% of the companies and 32% of them responded. These responses therefore present 7% (0.21*0.32) of all units assigned to this experimental group (actual completion rate).

The highest response measured with completion rate is therefore achieved in group A, what was expected due to the more intensive request for survey participation in the telephone survey. As expected, completion rate decreases from group A (63%) to groups D and E (32%) (from CATI - the most intensive solicitation and interviewing mode – to the use of mail or email for solicitation and Web for interviewing) (first column in Table 4.1.).

As already said, since we compare the Web survey mode to other modes, we are actually interested only in respondents who have access to the Internet. The final response rate therefore indicates the response of only units with access to the Internet. That means that for groups D and E where only those having access to the Internet were actually able to respond, final response rate equals actual completion rate (rate in brackets in first column in Table 4.1.). The comparison of final response rates therefore shows that telephone survey (group A) achieves responses from higher percentage of Internet users than the mail survey (group B). If mail is used for solicitation, the highest response from Internet users is achieved when the questionnaire is returned through the mail (group B), somewhat lower if it is returned through the fax (group C), and the lowest if the questionnaire on the Web (group D) is used. The lowest response of Internet users is achieved if email addresses are searched the public email directories, invitation is sent through email and the questionnaire on the Web is used (group E). However, if we again assume that 83% of units have access to the Internet and that email address is known from the sample frame for all of them, the final response in group E would be 27% (0.83*0.32) what is comparable to Web questionnaire with mail invitation.

[3] 33% of questionnaires in group C were actually returned by mail and not by fax. However this does not change the costs, therefore they are still included into the unified group C.

Looking at response for group F (Table 4.2.) gives us an insight into the mode preferences of respondents. Respondents most often chose the option of answering the paper questionnaire and returned it by mail (40% of all invited to the survey). Very rarely (only 3%) returned it by fax since their costs were higher in this case. They also rarely decided to answer the Web questionnaire (only 6%), however we should take into account that only those having access to the Internet were able to choose this option. Again, if we assume that 83% of all invited companies have access to the Internet, the actual percentage of those choosing the Web questionnaire among all able to chose it, is 8% (0.06/0.83).

Group	Completion rate	% having access to the Internet	Final response rate = having access to the Internet/initial sample size
F (mail-mail/fax/Web)	50%	/	39.6%
F1 (mail-mail)	40.3%	76%	30.6%
F2 (mail-fax)	3.3%	80%	2.7%
F3 (mail-Web)	6.3%	100%	6.3%

Table 4.2. Response for group F with self-selected options for completing the questionnaire

Lower response for groups where the Web questionnaire was used (groups D and E) and low respondents' preference for Web questionnaire in group F can be attributed to different reasons which can be classified into three sources of nonresponse: refusals, noncontacts and other noninterviews (Groves and Couper 1998). For example, specific reasons that may cause *refusal* in the establishment surveys is the business' policy about responding to the surveys and the difficulty of the task of completing the questionnaire (Paxson, et al 1995). The first limitation may be even more stressed in the cases where the Web questionnaires are used if company is worried about the Internet data security. Namely, users often regard the Internet as a threat to their privacy (Irving 1996; Smith, S. 1997), they worry about privacy on the Internet more than through the mail or over the telephone, often leave Web sites rather than provide personal information and sometimes even supply false information (Cho and LaRose 1999). We may expect that such concerns are even larger in the business world. On the other hand, the second limitation may be less serious in surveys with Web questionnaires since computerization of the questionnaire may allow to input data from other computerized sources. However, in our example this was not the case since no such data were required.

Another reason for lower response rate in group E is simply that the email was used for solicitation which may be regarded as a form of spam (Mehta and Sivadas 1995; Smith, C.B. 1997) and therefore driving into the refusal of the participation.

For group F, where respondents were able to select the mode of interviewing, low preference for the Web mode may be attributed to larger effort needed to answer such a questionnaire. While the paper questionnaire is already at hand, for the Web questionnaire the respondent needs to access the Internet. For Slovenian SMEs companies with access to the Internet this may be quite time consuming, since the majority of them (84%) still have dial-up access to the Internet (RIS 1996-2000).

The problem of *noncontacs* is larger in the establishment then in the household surveys as a consequence of inaccurate address lists, an inability to personalize correspondence, and the presence of gatekeepers (Bowers and Morton 1999; Paxson, et al 1995). All three reasons may have effected response in all of our experimental groups. For group E where email was used for contacting respondents the percentage of noncontacs may be even higher since the email address may be not existent or not used. The percentage of undeliverable email messages out of all sent messages was actually 7.3% (in comparison to 0 returned envelopes out of all sent mailings), however the percentage of not used email addresses is not know.

For the group E another reason for nonresponse may be the email address which belonged to a person not competent to answer the questionnaire but also not delivering the message to the right person. This reason may be classified as *other noninterview*.

In the following sections all calculations were done only for the companies having access to the Internet, since these are our target population. The final sample size for calculating the RMSEs is therefore the function of the completion rate and the share of companies having access to the Internet (the last column in Table 4.1.). However, when calculating the costs, the final sample size is only the function of the completion rate since the costs for companies with no access to the Internet also need to be included.

4.2. Differences in responses

In order to evaluate the usefulness of the different solicitation and interviewing modes, the response rates in the different experimental groups have been compared. However, another important question arises: Do all combinations of the different modes give same results? Are telephone respondents or mail respondents or Web respondents representative of the same population of Slovenian companies in terms of their use of the Internet and IC technologies? Or are they different in the sense that those responding on the Web, for example, are more intensive users or have more extreme opinions regarding the IC technologies?

In order to elaborate this issue, differences in responses by mode for three key variables in our survey are presented: % of companies having home page, % of companies having e-commerce application, and agreement (on 1-5 scale) with the statement that Slovenian government has done a lot for the optimal development of the Internet in Slovenia. We would expect that these variables have more extreme values in groups where less intensive solicitation and interviewing mode were used, therefore the most extreme in group E. The estimated percentages are actually different in different experimental groups, however they do not follow the expected pattern (Table 4.3.) and are (except in two cases) also not statistically significant[4]. The percentage of companies having homepage is the largest in group E (statistically significant difference) what is related to the method used for searching email addresses: only the addresses published in the public email directories or on the Web were included, therefore most of these companies have home pages. This group is therefore not comparable to others in this case. The differences among the other experimental groups are smaller. Mail and Web respondents (groups B and D) have home pages somewhat more often then telephone or fax respondents. On the other hand, the percentage of companies having an e-commerce application on their home page is the smallest in the group of Web respondents (group D) (statistically significant difference). The satisfaction with the government is very similar in groups where 'traditional' survey methods were used (A, B and C), but lower in the case of Web respondents receiving mail (group D) and higher for Web respondents receiving email (group E).

Group	Home page (i)	E-commerce application (ii)	Satisfaction with the government (iii)
A (phone-phone)	38.3% ± 7.6%	25.9% ± 6.9%	2.82 ± 0.17
B (mail-mail)	41.4% ± 8.9%	33.3% ± 8.5%	2.80 ± 0.20
C (mail-fax)	34.4% ± 9.5%	44.4% ± 9.9%	2.81 ± 0.18
D (mail-Web)	40.8% ± 10.9%	22.6% ± 9.3%	2.61 ± 0.27
E (email-Web)	76.9% ± 18.0%	30.0% ± 19.6%	3.25 ± 0.54

Table 4.3. Differences in the estimates of target variables (5% confidence intervals)

4.3. RMSE and costs

Table 4.4. first presents the RMSE for the three above mentioned key variables in the survey (i, ii, iii). Let's look at the example of the % of companies having home page. Although the bias (absolute difference among the estimate from the telephone survey and estimate from the group of interest) does not increase from group A to group E as expected, the RMSE does, due to the smaller samples in groups with less intensive solicitation and interviewing modes. However, this is not true for the percentage of companies having an e-commerce application on their home page: the RMSE decreases in group D, due to the small absolute bias. The RMSE is again the largest in groups D and E for the satisfaction with the government regarding the development of the Internet in Slovenia, due to larger absolute bias and smaller sample size.

Table 4.4. also includes the average RMSEs across all k=14 nominal variables in the survey that where measured as shares (iv), and average RMSEs for all k=9 variables that were measured on an interval scale (v). In both cases the RMSE increases from group A to group E, except for the group D where the average RMSE for the means is slightly smaller. We can thus conclude that on average, the survey error increases from the survey designs with more intensive to survey designs with less intensive solicitation and interviewing modes.

[4] The confidence intervals in Table 4.3. are calculated under the assumption that initial sample size in all experimental groups was n=300 and in this way comparable. If confidence intervals are calculated with actual sample sizes, results do not change significantly.

	RMSE					Overall costs (SIT)
Group	i	ii	iii	iv.	v.	
A (phone-phone)	0.03881	0.03498	0.08779	0.03355	0.07856	57.000
B (mail-mail)	0.05513	0.08626	0.10295	0.10677	0.24643	80.000
C (mail-fax)	0.06237	0.19225	0.09023	0.12631	0.25311	66.000
D (mail-Web)	0.06101	0.05772	0.25222	0.12036	0.22384	49.000
E (email-Web)	0.39681	0.10808	0.51018	0.1711	0.63397	6.000

Table 4.4. RMSE and costs for experimental groups at fixed (n=300) initial sample

For all the experimental designs the overall variable costs (costs for mailings, emails, telephone charges, data management and data entry) are calculated. Since the questionnaire was very short (3 minutes), the costs for the telephone survey (group A) are relatively low. For other designs, they decrease from group B to group E, as expected. These differences are in most part function of the solicitation mode used: phone solicitation most expensive, following mail with mail return option, then fax return option and finally Web questionnaire option. The least expensive mode was email solicitation with the Web questionnaire.

Empirical evaluations of the costs of the Web survey mode in comparison to other modes by other authors (Clayton and Werking 1998; Rosen, et al 1999; Watt 1997) confirm our findings. Of course, in a particular study, overall costs depend on several factors, for example on the length of the questionnaire which significantly influences costs in personal (telephone and face-to-face) and paper-and-pencil surveys (regardless of the mode) however not in the Web surveys. All such factors should be taken into account when comparing costs for a particular survey across different modes.

4.4. Optimum design

The table 4.5. presents the RMSE for the three key variables and average RMSE for shares and for means in different experimental groups when costs are fixed at 100.000 SIT. Different sample sizes could be used, depending on the costs for particular solicitation and interviewing mode. For example, for these costs, a CATI survey with the initial sample size of 529 units could be conducted, resulting in 275 responses from the companies having access to the Internet. Or a 'traditional' mail survey with two follow-ups and an initial sample size of 375 units could be conducted. If the email solicitation and the Web questionnaire was used, the initial sample size could be 4795 units (assuming that the email address is known for all of them) resulting in 336 responses.

			% having home page (i)		% having E-commerce application (ii)		Satisfaction with the government (iii)		Shares k=14 (iv)	Means k=9 (v)
Group	Initial n	Final n	p	RMSE	p	RMSE	μ	RMSE	RMSE	RMSE
A (phone-phone)	529	275	0.383	0.02931	0.259	0.02642	2.82	0.06631	0.02515	0.05933
B (mail-mail)	375	146	0.414	0.05108	0.333	0.08395	2.80	0.09221	0.10144	0.34572
C (mail-fax)	457	146	0.344	0.05555	0.444	0.18995	2.81	0.07340	0.11513	0.24379
D (mail-Web)	615	160	0.408	0.04620	0.226	0.04671	2.61	0.23154	0.11360	0.20079
E (email-Web)	4795	336	0.769	0.38668	0.300	0.04802	3.25	0.43544	0.14010	0.58174

Table 4.5. Optimum design for fixed costs

As an example, let's look how the RMSE for the % of companies having home page differs at these different scenarios. The lowest RMSE is obtained in the case of the telephone survey (group A), since the questionnaire is short and costs are therefore relatively low enabling larger sample. The next lowest RMSE is in group D, the mail invitation and Web questionnaire.

The average RMSEs for all nominal and all interval variables show that on average the telephone survey would be the optimal decision. In the case of shares, the next optimal design would be a mail survey. However, for means, the next optimal design would be the mail solicitation with the Web questionnaire.

Our example is, no doubt, a very specific one. In general, several different factors should be taken into account when comparing the errors and the costs across different designs. One extremely important is the length of the questionnaire. In our calculations the questionnaire was very short – only 3 minutes, therefore the costs for the telephone interviews were relatively low. If the questionnaire was longer, the costs for the telephone survey would be

significantly higher. The costs of questionnaires would also be higher in mail survey because of data entry costs and printing. However, the costs of the Web questionnaire would not change. The above calculations repeated with an assumption of the 15 minutes questionnaire actually give favorable results for Web option. In such a case, for a fixed budged, sample size for design D and E could be larger and the related RMSEs smaller.

5. CONCLUSIONS

In the paper the usefulness of the Web survey mode for establishment survey data collection was elaborated from the viewpoint of the survey errors and the survey costs. The following findings can be summarized:

- Respondents prefer answering a paper questionnaire and returning it by mail compared to answering the questionnaire on the Web. However, they prefer the Web questionnaire to the questionnaire returned by fax.
- The email solicitation proved to be inefficient due to lack of a good frame and due to the problems of within-establishment location of target respondents.
- Response rates for designs with the Web questionnaire are lower due to several reasons that vary for refusals, noncontacts and other noninterviews.
- Survey errors measured with RMSEs are comparable for paper and Web questionnaire with mail invitation letter, but higher for Web questionnaire with email invitation letter.
- Costs decrease from designs with more intensive to design with less intensive solicitation and interviewing modes, except for the telephone survey which was relatively short resulting in lower costs.
- For shorter questionnaires, the telephone survey is the optimal design since costs are relatively low. However, for longer questionnaires, a mail advance letter with the invitation to the Web survey potentially gives smaller survey error in comparison to other survey designs at the same fixed costs.
- With respect to the comparison with mail surveys we can observe that Web survey mode (with mail solicitation) provides comparable or even slightly better results than a pure mail option.

In the paper we were especially interested in reducing the nonresponse error which is only one type of nonsampling errors. However, with the change in the data collection mode it is possible that we do not influence only the nonresponse but also the measurement error, which may stem from the mode of data collection. However from the available data we are not able to establish what proportion in the change of the nonsampling errors occurs due to the change in the nonresponse error and what proportion due to the change in the measurement error.

Another methodological limitation of this study may arise from the relatively small sample sizes of certain subgroups. However, the major findings refer to the large enough sample sizes that provide sufficient guidelines for the non-continuous (ad-hoc) surveys of few thousands establishments. Of course, with large continuous establishment surveys other and more specific issues may arise. Nevertheless, the presented study may serve as an illustrative example of differences in response rates for different modes and how to evaluate costs in relation to errors of Web surveys.

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WEB-BASED COLLECTION OF ECONOMIC DATA AT THE U.S. CENSUS BUREAU

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ABSTRACT

With the extraordinary growth of Web use, especially by businesses, the Census Bureau has pursued testing data collection using the Web. In this paper, we provide an overview of four Census Bureau economic surveys that have used the Web for collecting data. We highlight issues that have arisen during this start-up period regarding respondent hardware and software, questionnaire design, security, coverage issues, implementing multi-mode designs, response rates, and motivation to use the Web. Potential benefits of Web data collection are discussed and related to our initial tests. We end by speculating about the future of Web data collection over the next decade for government economic statistical reporting.

Key Words: CSAQ, Internet, Security, HTML/JavaScript

1. INTRODUCTION

The Web holds potential data-collection advantages for both survey organizations and respondents. Electronic questionnaires can reduce respondent burden by providing features such as online help, auto-calculations, and in the business environment, importing of data from preexisting spreadsheets. Electronic questionnaires also have data quality advantages over paper such as the use of interactive edits, which allow respondents to correct their responses as they are entered. In addition, using the Web as a delivery vehicle is relatively inexpensive and fast compared to the postal service.

This paper provides an overview of economic data collection via the Web at the U.S. Census Bureau. We consider economic data to be data from businesses, farms and institutions, such as prisons, hospitals, local governments and schools. The growth of Web access at these places has been much faster than in households; thus the Census Bureau has concentrated its efforts into mastering Web data collection for them.

Beginning in 1997, the Census Bureau implemented several Web data-collection pilot tests and one full-scale production experiment. In this paper, we provide information pertaining to each of these efforts with regard to coverage, security, questionnaire design, response rates, and implementation issues. We also discuss whether the perceived or potential benefits were obtained, both from the survey organization and the respondent's point of view. We end by speculating about the future of Web data collection over the next decade for government statistical reporting, specifically for the Census Bureau.

2. BACKGROUND

Since the late 1980s, there has been tremendous change in the modes used at the Census Bureau to collect economic data. By and large, most economic data collection in the early to mid 1980s was conducted via mailed, paper-and-pencil, self-administered questionnaires with both mail and telephone follow-ups for nonrespondents. During the late 1980s to early 1990s, a flurry of new technologies were tested at the Census Bureau for self-administered economic data collections. Those included touchtone-data-entry (TDE), FAX, and diskette-based electronic questionnaires. The diskette-based electronic questionnaires, which we refer to as computerized self-administered questionnaires or CSAQs, were the forerunners of the Web data-collection efforts. Once we had an electronic questionnaire, changing the media in which the questionnaire was accessed, i.e., from diskette to the Web, was a logical next step.

The majority of Census Bureau sponsored requests for economic data are still implemented using paper-and-pencil mail surveys. Many requests, however, use a multi-mode approach where the respondent is offered a choice. To some extent the excitement over TDE and FAX-based reporting has slightly diminished, and more emphasis has been given to expanding Web-based reporting.

Four economic surveys at the Census Bureau have thus far offered a Web-reporting option: the Industrial Research and Development Survey (R&D), the Report of Organization Survey otherwise known as the Company

[1]This paper reports the results of research and analysis undertaken by Census Bureau staff. It has undergone a more limited review than official Census Bureau publications. This report is released to inform interested parties of research and to encourage discussion. The authors thank Elizabeth Murphy, Kristin Stettler, Lelyn Saner, Katja Lozar, and Vasja Vehovar for their useful comments.

Organization Survey (COS), the Library Media Center Survey (LMC), and the Manufacturers' Shipments, Inventories, and Orders Survey (M3). The first two are annual surveys conducted on businesses. The R&D contains approximately six main items. One of the items contains several subitems. The COS collects employment and payroll for all establishments in a business. It is a lengthy survey for large multi-establishment businesses. The LMC is a survey of public and private elementary, junior, and secondary school libraries. It occurs every five years and contains approximately 40 items. The M3 is a short monthly voluntary survey of large manufacturers. It collects seven main items.

The 1996 R&D was the first survey to offer a Web-reporting option to a sample of companies. It was considered a pilot test and was not repeated in subsequent years. The 1998 COS also offered a Web-reporting option to a sample of companies; this sample was expanded for the 1999 COS. The LMC offered a Web-reporting option to the 1998-99 field test sample and the 1999-2000 full-scale production sample. The M3 is offering a Web-reporting option to selected companies starting in 2000. This sample might expand as interest and ability grows. Following a general discussion of Web CSAQ benefits, this paper summarizes the implementation and results from these Web reporting applications.

3. MOTIVATION TO USE WEB CSAQS

Web CSAQs potentially benefit both the data provider and the data collector. Many economic respondents have access to computers, very often at their desks. In large businesses, these respondents are often computer savvy accountants who use their computers daily for normal business operations (Nichols, et al. 1999). We also speculate that other economic respondents, whether they be farmers or librarians, are computer literate and have access to computers. As compared to household surveys, offering such an electronic-reporting option might be more readily accepted by economic respondents because they have greater access and ability. Lack of access and ability might be more of an issue for smaller organizations, but even then we suspect computer access and ability will grow over time.

Functionality programmed into CSAQs, such as skip patterns, sound, and additional probing for questionable answers (i.e., edits), allows researchers to bridge the interactivity gap between paper self-administered and interviewer-administered questionnaires. These changes can improve data quality and decrease respondent burden, especially in complex questionnaires (Turner, et al. 1998; Bloom 1998). For example, edits built into the instrument can check for keying errors in real time, saving the respondent from a future telephone follow-up call asking about questionable data. In addition, once the questionnaire is automated, there is no need to key data from a paper form when it arrives at the survey organization. Not only is data quality improved, since keying errors are eliminated, but the cost associated with the keying process is also eliminated for the survey organization.

Economic entities, such as businesses or libraries, often store their records on computers. Many economic data requests require look-up from records since the answers are factual and are not stored in the respondent's memory (Edwards and Cantor 1991). A computerized questionnaire or CSAQ puts the form in the same media as the records. Often these computerized questionnaires offer an importing feature, whereby respondents can read data from a spreadsheet directly into the survey instrument. In theory, this automates the entire process since data move directly from respondents' automated records into the automated questionnaire. For frequently occurring data requests, this import feature can save the respondent a lot of time, and it avoids transcription errors. Some CSAQs also offer an exporting feature, where the respondent can make a data file for their records.

In addition to these benefits, Pilon and Craig (1988) document a "novelty effect" with CSAQs, suggesting increased response rates over those of traditional self-administered paper questionnaires. The automated instruments are perceived as more fun and taking less time than traditional paper questionnaires. Perceived benefits are very important, since it is the respondent who needs encouragement to complete the survey, especially for voluntary surveys or surveys whose response rates have been slipping. At the very least, survey organizations speculate that offering these instruments is another way to maintain response rates.

The previous examples pertain to all CSAQs. Adding a Web option either for accessing the CSAQ, sending data to the survey organization, or both, saves the survey organization costs associated with diskettes, such as their purchase and mailing, and has the potential for faster response, since no mail service is needed. In addition, access to the Web is growing at a tremendous rate, especially at economic entities, many of whom already have their own Web pages, engage in e-commerce activities, and use the Internet or an Intranet to communicate outside and within their own organizations. Offering a Web CSAQ option brings the survey organization to status quo in the business world and was enthusiastically embraced by many large companies during personal visits made in order to find ways to reduce reporting burden (Willimack, et al. 1999b).

4. IMPLEMENTATION OF WEB CSAQS

Implementation of Web CSAQs has evolved at the Census Bureau. A number of questions have arisen, including what programming language to use, what features to embed in the questionnaire design, how to meet security requirements, and how to select respondents for this option. Table 1 contains a summary of the different implementation schemes used for the different survey requests in which the Census Bureau has offered a Web CSAQ option.

Table 1: Summary of Census Bureau Web CSAQ Implementation

Survey	Questionnaire Design: Language & Features	Security	Respondent Selection
1996 R&D	HTML w/JavaScript No importing or exporting Included: edits, online help, print capability, evaluation questions, historical data, and partial submission	Netscape 3.0 + 40-bit encryption/ One user name and password letter for authentication/ Firewall	Screener first and then mailed Web CSAQ letter only to selected screener respondents 50 received only Web option
1998 COS	Delphi downloadable executable No exporting Included: importing, edits, online help, print capability, evaluation questions, and historical data	Netscape or MSIE 3.0 +, US only browser 168-bit encryption/ Separate user name and password letters for authentication/ Firewall	Screener first and then mailed Web CSAQ letter to selected screener respondents 30 received only Web option 18 received diskette and Web return option
1998-99 LMC field test	HTML w/JavaScript No importing, exporting, or historical data Included: edits, online help, print capability, an evaluation question, and partial submission	Netscape or MSIE 3.0 +, US only browser 168-bit encryption/ Separate user name and password letters for authentication/ Firewall	No screener Mailed paper questionnaire and Web CSAQ letters together to all 924 schools in the sample
1999-2000 LMC	HTML w/JavaScript No importing, exporting, or historical data Included: edits, online help, print capability, an evaluation question, and partial submission	Netscape or MSIE 3.0 +, Export browser 40 to 128-bit encryption, Global Server Certificate/ User name letter and password described upon Web Site access for authentication/ Firewall	No screener Mailed paper questionnaire and Web CSAQ letter together to all 13,440 schools in the sample/ split panel test
1999 COS	Delphi downloadable executable Included: importing, exporting, edits, online help, print capability, evaluation questions, and historical data	Netscape or MSIE 4.0 +, Export browser 128-bit encryption, Global Server Certificate/ One user name and password letter with respondent completion of profile upon Web Site access for authentication/ Firewall	Telephone follow-up of 1998 CSAQ panel respondents who indicated interest in Web reporting based on evaluation questions responses; mailed Web CSAQ letter to selected respondents 191 received only Web option 3 received diskette and Web return option
April 2000 M3	HTML w/JavaScript No importing, exporting, or evaluation questions Included: edits, online help, print capability, partial submission, and historical data	Netscape Communicator 4.06+ or MSIE 4.02 +, Export browser 128-bit encryption, Global Server Certificate/One user name and password letter/Digital Certificate for authentication/ Firewall Verisign e-mail partner	Screener letter first; mailed Web CSAQ letter only to selected screener respondents 75 received only Web option; once established, additional respondents can be added monthly to panel

4.1 Questionnaire Design: Features to Include

During the instrument design phase, the Census Bureau has implemented CSAQ features consistent with the needs of the respondent for each particular data collection. Based on company visits, usability testing, and prior evaluation responses, we have determined the features that are important to economic respondents. Our hope is that these features aid data collection in terms of quality and timeliness, while reducing respondent burden.

- We found that print capability is important for economic data requests because respondents like to have a copy of the data submitted for their records. Visits to large companies demonstrated that they use these printed versions for responding to subsequent requests (Willimack, et al. 1999a; 1999b). In addition, evaluation responses indicate that 60% of respondents print the form (Sedivi and Nichols 1999). We've made available a printing option in all our economic Web CSAQs thus far implemented.
- Submitting only part of the data at a time is also useful for economic respondents, since the data requested typically have to be obtained from records, which are not always immediately accessible (Edwards and Cantor 1991; Willimack, et al. 1999b). Even though respondents can't submit part of their data to the Census Bureau using the COS executables, they can save their data to their hard drive. Thus, they can return later to the instrument populated with their saved data.
- Historical data are more likely to be present for regularly occurring data collections than for less frequently occurring or one-time data collections. This is the case for all modes. Many of the Census Bureau's economic data collections occur on a regular basis and contain embedded historical data. So our Web CSAQs contain historical data to aid reporting when available.
- Importing and exporting options are useful when data are already stored electronically or when there is a need to manipulate data electronically after the data collection is completed. In addition, importing is really only useful when the same variables are requested repeatedly, for example in a frequently occurring survey or a survey which requests the same data, but for different units within the organization.

Most data-collection processes include an edit phase. One CSAQ advantage is the ability for real-time data editing. This reduces the post-processing phase of subsequent follow-up phone calls to the respondent concerning questionable data. In addition, help is needed not only for economic data collections, but for all Web applications. We have offered on-line help in all the instruments. Based on the evaluation responses and user metrics, we found few used the on-line help (Sedivi and Nichols 1998; 1999). More widely used by respondents is a technical help desk which they can call when questions arise. All applications have offered a help desk for technical assistance.

The addition of evaluation questions is useful during the development of these CSAQs in order to find out what works, what doesn't work, and what is useful for respondents. This is especially worthwhile for frequently occurring data collections where the instrument can be adjusted based on comments. However, even for one-time surveys, it may provide feedback that can be transferred to other surveys. The Census Bureau has embedded evaluation questions, except for the initial M3 questionnaire. An evaluation of the M3 will be conducted after the first couple of months of testing.

4.2 Questionnaire Design: Programming Language

Two different types of Web questionnaire designs have been implemented. Except for the COS, we have used a Web form displayed within the browser window. The advantages of this approach are that the form doesn't need to be installed on the respondent's system, and data can be temporarily saved to the agency's Web server if multiple sessions are required to complete the survey. Disadvantages of this form type include the inability to import or export data directly into or out of the client-side survey instrument. Additionally, download time and system limitations may constrain the size of the instrument. In order to have real-time editing, pop-up features, or sophisticated navigation beyond scrolling, the HTML language needs either to be supplemented by the use of a programming language such as JavaScript or replaced by a programming language such as Java. Unfortunately, these may be interpreted differently by the various browsers since standards for Java and JavaScript have not yet been established. For our economic data collection instruments, we have used JavaScript in order to provide additional functionality, especially real-time editing.

The COS instruments are executable programs that respondents download over the Web and install on their hard-drives. Although this requires more initial work by the respondent, there are no browser limitations on importing, exporting, or the application size. However, application size does affect download time. The annual COS CSAQs have an importing capability, which is especially important since payroll and employment are requested for all the locations in a business. This proves to be burdensome for large businesses with many locations. Sedivi and Nichols (1999) document that the exporting option was requested in some of the 1998 COS evaluation

responses. Exporting was included in the 1999 version. Our decision on whether to create an executable or a browser-dependent questionnaire is related to the type of data collection. For those where importing is critical, the browser-dependent form does not withstand the advantages of an executable.

4.3 Security Requirements

The browser, connection type and speed, and operating system affect the functionality of all these questionnaires. We have designed economic Web questionnaires to function properly on a defined configuration. Typically we request a Windows 95 or NT platform with either Netscape Communicator or Microsoft's Internet Explorer. Our encryption solution requires respondents to have version 4.0 or higher of the browser to enable strong 128-bit encryption.

A motivating reason for these restrictions was the security design we imposed due to Title 13 (for the R&D, COS, and M3) and the less restrictive Title 20 (for the LMC surveys). A three level security system including encryption, authentication, and a firewall, is used at the Census Bureau. Encryption insures the data security as it travels from the respondent's PC to the Census Bureau and vice versa for applications with historical data loaded or partial submission features. Each browser version supports a different level of encryption. Our first Web experiment (the 1996 R&D) required only a 40-bit encryption, which could be obtained using an export version of the browser. Working with the National Institute for Standards and Technology (NIST) to develop a Census Bureau standard for all Web data collections, we used a 168-bit Triple DES encryption for the 1998 COS test and 1998-99 LMC field test. This, however, required a Netscape or Microsoft Internet Explorer (MSIE) 3.0 domestic (U.S. only) version of the browser. We believe this directly affected the ability of many to access and use the instrument and led to the overall poor response rate for this test, as seen in the next section. Because of the poor response rate to the 1998 COS test and LMC field test, we worked with the Department of Commerce (DOC) and NIST to gain the use of a product called Global server certificate developed by Verisign, an Internet security company. The Global server certificate increases encryption between the Web server and an export version of the browser from 40-bit to 128-bit, which is considered strong encryption. This occurs only if the export version of the browser is 4.0 or higher. If not, the respondent will be denied access. However, because of the LMC survey's less strict confidentiality, for that survey only, we allow encryption as low as 40-bit with a browser as low as version 3.0.

Authentication, or our ability to make sure the respondent is not an imposter, has also evolved. For our first test, we sent out a username and password survey notification letter with the URL via certified mail. Reminder follow-up letters were mailed to Web nonrespondents on the same schedule as the other nonrespondents. However this follow-up letter did not contain the URL, username or password. Based on phone calls to our help desk, we determined that many respondents lost the earlier letter with the critical access information. For subsequent tests, we mailed two separate letters via U.S. postal service. One contained the username; the other letter contained the password. Both contained the URL. Follow-up nonresponse letters followed a similar design. If one letter was intercepted, the imposter was not able to access the instrument. It is unclear how often interception happened, or how often the respondent misplaced or never received one of the two critical letters. These concerns caused us to redesign our delivery of username and password. The new authentication plan is different for each survey depending on that survey's degree of confidentiality, existence of historic data, and use of partial submission of data. For the most recent tests we used one letter containing both the username and password for the initial mailout and follow-up. We are also continuing to research methods of authentication to provide the needed security without compromising usability. We are testing digital certificates for the monthly M3 survey. Respondents enroll for a digital certificate, which is then installed in their browser. Respondents present the digital certificate to access the survey. Digital certificates can be used for both digital signature and encrypted email. M3 respondents indicated their email system during prescreening. In order to use encrypted email for reminder letters, only respondents whose email system is a partner with Verisign were selected.

Once received at the Census Bureau, the data are protected by a firewall, which guarantees that others from the outside cannot have access to the data. The firewall allows us to limit the communications protocols that can reach our CSAQ Web server. Only the HTTPS protocol, which provides encrypted communications, is allowed. The firewall also controls communications between the Web server and our database and security servers. The CSAQ Web server is the only system on our public network that is allowed to communicate with these servers.

4.4 Respondent Selection

Web access and ability are necessary in order to use any of the CSAQ instruments. Since access and ability (i.e., coverage) have yet to reach the entire economic respondent population, we offer the Web as one of several possible response modes. In addition to resolving the questionnaire and security designs, the Census Bureau also has tested a number of different selection schemes to recruit Web CSAQ respondents. The easiest selection

technique is to offer the Web CSAQ as an alternative to the entire sample. The LMC tests mailed the paper questionnaire with a notification of an on-line Web questionnaire option. This selection strategy was used in part because Web access at school libraries was high (89 percent), according to the U.S. Department of Education (Tedesco, et al. 1999). Although prescreening possible candidates is not needed using this scenario, cost savings are minimal since the paper questionnaire is mailed to the entire sample. With such an open-ended selection strategy, researchers cannot empirically study the effect of Web reporting on response rates, timeliness, or data quality. Lastly, there is a certain amount of risk running a pilot test within a production setting. Controlling access limits possible damage (e.g., low response rates or poor data quality) on estimates and variances.

For these reasons, the R&D, 1998 COS, and M3 used a prescreening paper questionnaire for selection. For screener respondents who reported interest and ability, a sample was selected, and the Web reporting option was made available to them. To select 1999 COS Web mode recipients, phone calls were made based on positive response to the 1998 COS's evaluation question regarding interest in reporting via the Web for future data collections.

Since we've implemented only small scale, prescreened pilot tests, no cost savings have materialized even though multi-modes are not mailed to the same respondent. In fact using a screener increases total costs in these cases. In addition, prescreening is not foolproof. We've documented a number of instances where the person who responds to the screener and expresses interest and ability, is not the ultimate respondent to the survey (Sedivi and Nichols 1999; Nichols and Sedivi 1998). Occasionally the ultimate respondent does not want to complete the CSAQ via the Web and has no knowledge of any previous conversations with the Census Bureau regarding the issue. In the R&D and 1998 COS studies, we also encountered screener respondents who inaccurately claimed Web access. We've found a need for procedures in order to convert respondents who want or need to switch modes during production.

To increase response rates for paper mail questionnaires, Dillman (1978; 2000) advocates a follow-up regimen including reminder postcards/letters, second mailing of the questionnaire, etc. The Census Bureau adopts the same follow-up strategy for all modes within a survey. This usually consists of a series of follow-up letters and sometimes a duplicate questionnaire. In addition, since Web collection is a new mode, we also have frequently called nonrespondents (especially those prescreened to receive the instrument) to determine reasons for not responding. As the mode becomes production oriented, we suspect these time consuming follow-up phone calls will diminish. Sending reminder letters via email or encrypted email will be explored in the future.

5. RESULTS FROM WEB CSAQ IMPLEMENTATION

Table 2 contains a summary of the results from each of the different economic survey requests in which the Census Bureau has offered a Web CSAQ option. Shown are the results of the screener, if there was one, Web CSAQ response percentage, reasons for response and nonresponse based on follow-up phone calls and evaluation responses. Screener results indicate willingness to use the Web, access to the Web, and the ability to use the Web CSAQ, given the Web survey's specific browser and hardware requirements.

Table 2: Census Bureau Web CSAQ Results Summary

Survey	Screener Results	Response Outcomes	Follow-up Questions
1996 R&D	47% returned (1,234/2,615) 42% willing and Web access (523/1,234) 6% willing and able (73/1,234)	68% Web (34/50) 84% nonWeb= (paper, diskette, modem of which 15% used the diskette) (n=2,552)	96% (27/28) of Web panel are interested in Web option for next period
1998 COS	55% returned (154/278) 31% willing and able (48/154)	27% Web (13/48) 58% diskette (762/1317) 83% paper (42,051/50,404)	71% of diskette and Web panel are interested in Web option for next period
1998-99 LMC field test	N/A We estimated 89% had Web access.	42% overall (388/924) 2% responded via Web (9/388)	80% of nonrespondents had Web access -Many did not have or know if they had the US-only browser
1999-2000 LMC	N/A	63% overall (8,433/13,440) 12% responded via Web as of 3/28/00 (1,658/13,440) Split panel test results: 17% Web (treatment group; n=6719) 7% Web (control group; n=6721)	to be determined
1999 COS	89% willing and able (telephone screener) (194/219)	74% Web (144/194 as of 7/13/00)	to be determined
April 2000 M3	27% returned (809/3,058) 81% willing & Web access (651/809) 7% willing and able (61/809)	31% Web (23/75) for April statistical period 72% Web (54/75) for May statistical period	to be determined

The screener responses suggest that Web access is growing, even though none of the studies is a scientific sample, and comparison across designs is questionable since they are slightly different populations. In 1996, 48% of R&D responding firms had Web access (not shown). Two years later this increased to 59% of COS screener respondents (not shown). In 2000, 87% of M3 screener respondents had Web access (not shown), suggesting rapid growth in accessibility. In addition to Web access becoming more common, more respondents are acquiring current operating systems and higher browser versions. In 1996, only 6% of the screener respondents had the necessary operating system (Windows 95) and browser version (Netscape 3.0 or higher) and were willing to complete the Web questionnaire, but two years later 31% of businesses had an even higher browser version, Windows 95 and were willing to use the Web. In 2000, 72% (not shown) of M3 screener respondents were willing to use the Web and had the necessary operating system and browser (some didn't indicate the version), but only 7% also had the necessary email package that could handle security encryption and wanted to receive email reminders.

In addition to the growth in Web access, interest in reporting using the Web is also increasing. In the 1996 R&D evaluation responses, most of the Web reporters said they would report using the Web next time. Based on the 1998 COS evaluation responses, approximately 71% (220/312) of both Web and diskette panels said they wanted to use the Web next time. Lack of Web access is still the primary reason why respondents did not want to use the Web. Concern for security was another reason why respondents would not want to use the Web, but we estimate that was a factor in only about 15% (10/65) of the cases (Sedivi and Nichols 1999b).

Even with interest and access growing, the final response outcome has been mixed. As shown in Table 2, we've experienced lower than expected response using the Web mode. For example, only 2% of the 388 respondents to the 1998-99 LMC field test responded using the Web. The overall response rate to the field test was low at 42%, but we were very surprised so few respondents used the LMC Web mode. Based on follow-up phone calls to nonrespondents we found that they considered the strict browser requirement burdensome. Although about 80% of the follow-up call respondents had access to the Internet, many (46%) did not know whether they had the US-only browser, and over 40% of them were not willing to download the correct browser version. Nearly one third (32%) of the follow-up call respondents said they had a US-only version of their browser, but we are a little skeptical since

research from the 1998 COS Web experiment (Sedivi and Nichols 1999b) indicates some misreporting of browser type and version.

Nearly 6% of the respondents to the 1998-99 LMC follow-up phone calls indicated they tried the Web-based version but were unsuccessful in accessing it. This failed access probably occurred because they had the wrong browser version or encryption level. We could not determine the actual number of respondents who attempted to use the LMC but were unable to because of browser problems. Follow-up calls to the 1998 COS Web panel nonrespondents resulted in similar findings.

Although the need to keep data confidential and secure is a critical issue for survey agencies, we encourage designers and sponsors to balance the need for security with respondents' need for an easy reporting option. The 1999-2000 LMC Web-based survey has more lenient security requirements, and the percentage of respondents who used the Web reporting option increased as compared to the field test.

Another factor that could have affected the marginal usage of the 1998-99 LMC Web form was that the package contained the paper questionnaire. Most telephone follow-up respondents (73%) reported receiving the questionnaire, and 70% were aware that a Web-based option existed. So, we conclude lack of knowledge concerning the Web reporting option was not a reason for not using the Web. We hypothesized that many respondents were not motivated to use the Web even though they had access, since the paper form was easily available. To determine whether we could motivate respondents to use the Web form even when a paper option was present, a split panel test was conducted within the 1999-2000 LMC test. Half the sample received a control letter informing them about the Web option; the other half received a letter informing them of the Web option and highlighting advantages of Web reporting. The treatment group also was encouraged to use the Web during nonresponse follow-up telephone calls. Overall, Web response increased to 12%, which we attribute to the lowering of the browser requirements and the use of one survey notification letter. The treatment group (more encouragement for Web option) replied by Web more than twice as often as the control group, for both public and private schools, which suggests that highlighting Web advantages motivates some respondents to use that mode (Hoffman, 2000). Finding ways to convert nonrespondents is a goal of survey organizations. Unfortunately, we do not have concrete evidence that offering a Web option in addition to another mode increases the overall response rate. The LMC response rate at 63% was higher than the field test (which is to be expected), but the treatment and control groups had identical overall response rates, for both public and private schools. We might expect an overall higher response in the treatment group, if offering a Web option increased response. Unfortunately, this experiment does not provide a clean comparison. The Web option was offered to both groups, only emphasized more in one. A certain percentage reported via the Web in both groups. If a Web option didn't exist, those individuals might or might not have been respondents to the paper form.

Even more curious was the low Web response when prescreening was used. (Most Web panel nonrespondents eventually reported using another mode.) For both the R&D and the 1998 COS, we experienced low Web response, even after respondents were prescreened. These selected respondents claimed they were interested and had the ability to report via the Web. Again, we feel the strict security caused the low response to the 1998 COS, but we are not sure why the 1996 R&D had a low Web response. Some possible explanations include (1) the Web CSAQ is not as visible as the mail package containing the paper questionnaire, (2) the additional task of keeping track of the username and password was too much for respondents, or (3) the person who completed the screener was not the person who would complete the CSAQ. We do not feel that the design of the questionnaire, or the software needs were primary causes of the poor response rate for either design since usability testing was done prior to 'mail-out.' The low response rate was driven by companies who never even tried to access the CSAQ.

In any event, this tendency should be evaluated since it has follow-up cost considerations. Response to the 1999 Web COS is already an improvement over the 1998 COS response. The M3 response will be a good indicator of whether this disconnect continues between screener responses and the Web response to the survey. These surveys are using the Global site certificate and one survey notification letter containing their username and password.

6. CONCLUSIONS AND FUTURE RESEARCH

The Census Bureau is continuing to pursue Web-based reporting for these data-collection efforts and for future economic data collections. In June 2000, a new survey collecting E-commerce and computer network use data will offer a Web-reporting option. A split panel design is proposed, with half the 52,000 sample (the Annual Survey of Manufactures panel) receiving only the Web option during the first mailing; the other half receiving both paper and a Web option. The 2002 Economic Census is offering a Web-reporting option as one of three possible modes for

responding, the other two being paper and diskette. The 2002 Economic Census is a massive undertaking with approximately 500 forms for 1100 industries and 3.3 million mailed establishments. Although there are no empirical studies yet planned for the Web-reporting option within this data-collection effort, there is a need to scientifically study a few aspects of Web-based reporting.

From the data collector's viewpoint, there is still a need for empirical evidence supporting the notion that Web-based reporting reduces survey organization cost and improves data quality. Thus far, most of the studies have been small. In addition, companies have not been randomly assigned to particular modes. The split panel within the E-commerce survey will provide some insight into whether a Web only option can maintain or improve response rates over the more costly multi-mode approach.

In addition, we have not empirically proven that Web-based reporting lessens respondent burden, even though there is evidence that companies want to respond by this mode. A few aspects of the implementation could actually increase burden. For instance, requiring a browser that many respondents don't use, and using usernames, passwords, or URLs requires additional burden a paper form does not impose. In addition, requiring Web reporting when the respondent's work environment is not suited to that type of reporting could also increase burden.

Proving reduced burden is difficult. We can qualitatively ascertain whether Web-based reporting reduces reporting burden. Factoring in the respondent's work environment early in the design cycle through a task analysis could also suggest whether a respondent's particular job is suited to Web-reporting even when there is access and ability. Company visits, focus groups, and usability testing are ways to find out how to improve the instruments and provide more of the functionality respondents want and need. Post-evaluation questions also provide some information regarding lessening reporting burden. For example, approximately 10% of the 1998 COS CSAQ (diskette and Web) evaluation respondents said that what they liked most about the electronic survey was that it saved time compared to filling out the typical paper form. This is a qualitative burden reduction finding. This example highlights the fact that the perception of burden reduction is as important as actual burden reduction, perhaps more so.

There are other perception issues with regard to completing a survey via the Web. For example, the perception of Web security risks still existed for 3% (10/312) of the 1998 COS diskette CSAQ evaluation respondents. For the 1996 R&D screener respondents, 4% (22/587) of the respondents who had Web access didn't want to respond using that mode because of security risks. In addition, incorrect perception of how the COS instrument would function on the Web dissuaded a few potential 1999 COS respondents. There are also response motivation issues when another mode is present. Our experiences clearly demonstrate that it is not a given that respondents will choose Web just because it is "new" or "fun." It is critical that respondents perceive some advantage to the Web-based reporting option, as shown by the 1998-99 LMC test. Novelty alone does not appear to be enough to entice respondents to choose the Web, even when there is high Web coverage. This becomes particularly true when there are barriers to reporting via the Web, such as having to locate a paper username and password, having to download the appropriate browser, or having a job that is not ideally suited to computerized data collection. While these perception factors are ultimately out of our control, we can influence them and need to develop communication vehicles to do so. Luckily, for economic respondents, some motivating factors can be emphasized. The 1999-2000 LMC split panel test demonstrates the effectiveness of motivational messaging. Response to the Web option improved when motivating factors were pointed out to respondents. Perhaps the same type of motivational messaging can convey to respondents that security on the Internet is resolved.

The future holds promise for Web CSAQ use for economic data collections, especially for large periodic surveys. The efficiencies of such a mode can motivate both the respondent and the data collector. It is clear that emphasizing the efficiencies is critical in order to maintain overall response rates and overcome any obstacles grounded in respondents' perceptions.

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PROGRESS IN USING THE WORLD WIDE WEB TO CONDUCT ESTABLISHMENT SURVEYS: COMMENTS ON THREE IMPORTANT PAPERS

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There can be no doubt that use of the World Wide Web to conduct establishment surveys will increase. The three papers in this session tout the potential advantages of such surveys. They also provide data that describe and evaluate attempts to collect data from establishments via the web. Each of them is an important paper with useful insights into the challenges the must be faced for web surveying to become common place. I recommend that all three of them be read carefully by anyone interested in conducting establishment surveys via the World Wide Web.

The paper in electronic data collection in selected BLS establishment surveys by Clayton, Searson, and Manning is a much anticipated, and in many ways the "next chapter" in a long series of papers one of which was presented by Werking and Clayton at the 1993 ICES Conference. The current paper describes beginning efforts to convert collection of monthly employment data under the Current Employment Statistics Program to the web, following its earlier conversion from being primarily a mail survey to CAI, TDE, VR and EDI. By 1996, nearly 60% were reporting by TDE and some of the largest multi-unit companies reported through EDI. A conversion attempt for another program is also reported in this paper.

The pilot attempt to convert to WWW collection, although small (100 firms), appears to be well thought out and has produced a response rate similar to that achieved by TDE. This response is higher and achieved much faster than that obtained by traditional mail methods, and operates at one-fifth the cost of mail collection.

We are entering an era in which the development of tailored survey designs is essential. By tailored design I mean adapting procedures to the survey situation. Mixed-mode surveys will dominate this feature, and we need to design with this consideration in mind. The implication is that we'll likely achieve our best response rates and measurement if we use a communication strategy that is respectful to respondents and shaped to meet the needs of different respondents.

The paper by Clayton, Searson and Manning illustrates these aspects of *Tailored Design*. The Current Employment Survey must be completed monthly and asks only 5-6 questions. Had the authors approached this important survey by trying to transform all 390,000 establishments immediately to the web, the objections as well as the problems would have been enormous. Rather, they have developed web survey procedures for only a small number of firms (100), following a procedure similar to that followed when they began substituting CATI, TDE, and EDI for the traditional mail-out, mail-back procedures used for this survey. The web communications illustrated in the paper strike me as particularly well written. I expect to see an effort similar to previous ones to systematically convert respondents, over a period of years, from other survey modes to reporting via the web. Yet, I expect that this survey will continue for many years to have people reporting by different survey modes.

The exact procedures reported here will not be appropriate for many other surveys, e.g., ones with many questions, and less frequently reporting. However, the innovation process model that this paper illustrates is one that should be contemplated carefully by most if not all sponsors of establishment surveys.

The agency and the authors are to be applauded, not only for the work reported in this paper, but the continuing progress that has been made to gain cost efficiencies and speed for the collection of establishment data by the federal government.

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One reason for their success is recognition that conversion cannot be made all at once, and that the continued use of multiple-modes of data collection are therefore necessary.

I want to suggest that the next paper for Clayton and his colleagues should not be a follow-up on how many additional people they have converted to web surveys. Rather, I would like to know how they have managed to accomplish this important, decade-long program of innovation. What are the organizational features, the individual efforts, and the division of interests across divisions that has made it possible to initiate and successfully transition this survey from mail to other more effective methods? Also, what are the job skills that are no longer relevant to you data collection, and the new ones that are essential? Have you made changes while relying on the same people or different ones? I believe all of us have something to learn from your experiences about how innovation, a great need in many other establishment surveys, can be accomplished.

The paper by Vehovar, Manfreda, Batagelj and Zaletel is one of several useful papers produced by this group of researchers in Slovenia, who are systematically helping us to understand the strength and limitations of web surveying. This paper explores the costs and errors associated with conducting telephone, mail, fax and web surveys of Slovenian companies. It uses a research model that focuses on nonresponse error instead of response rates, and explores methods for minimizing mean square error at given cost levels.

One of the main strengths of this paper is that it reports results from an experiment on several different modes of surveying establishments. It also illustrates a style of research design and analysis that individuals interested in understanding the strengths and limitations of web surveys should read carefully. Without repeating details from the paper, the paper considers many specific issues, ranging from differential response rates and different modes of responding (phone, mail, fax, e-mail) to the widely differing distributions of answers by mode, all of which provide information for thoughtful contemplation by the reader.

This paper has a number of limitations–the questionnaire was very short (only three minutes) and sample sizes were fairly small for some of the groups. In addition, the nature of possible measurement errors, which might be expected to vary because of the use of aural vs. visual methods of asking questions, was not considered in the analysis. Nonetheless, this paper raises many interesting issues for thoughtful contemplation. It also contains an excellent set of references from perhaps the most comprehensive bibliography on web surveys that now exists (http://surveys.over.net/method).

The paper by Sedivi, Nichols and Kanarek overviews experiences at the U.S. Bureau of the Census in attempting to use the web to collected data in four different economic area surveys. This too is a well written paper, and is one I would have read carefully, regardless of whether I was asked to be a discussant. The detail on things that worked and others that did not work so well is particularly instructive for professionals who plan to design web surveys.

This paper offers a significant contrast with other papers in this session. Whereas Clayton et al. appeared to ask how they could best facilitate helping participants in the CES who were willing to report via the web, to adopt that style of reporting, this paper takes more of an advocacy approach of "selling" the web to respondents. It seems to accept as a starting point that people should find responding to surveys via the web advantageous. It then reports trying to develop procedures aimed at converting respondents from other "less desirable" survey modes to the web. For example, a lengthy section of the paper describes the benefits of responding via the web (e.g., "The automated instruments are perceived as more fun and taking less time than traditional paper questionnaires."), but says virtually nothing about the likely disadvantages. Rather, than focusing in large part on how webs might be one of several modes of responding, it focuses more on trying to get respondents to reject other modes and to accept the web approach (e.g., "To determine whether we could sell the advantages of a Web form even when a paper option was present.").

The response rates achieved to web questionnaires in two experiments reported here was lower than for other forms of responding. It appears that part of the reason was the use of web programming procedures that were too advanced for respondent computers and their telecommunications situations. I also had the impression that relatively little attention was given to building the sequence of contact and related implementation procedures necessary for achieving high response rates. For paper questionnaires response rates have depended far more on implementation procedures than they have on questionnaire construction. I believe that will hold true for web surveys as well. Web surveying adds to that challenge, conveying information effectively about access codes (as noted by the authors), and making sure that all respondents who want to access the web questionnaire can do that.

I would like to encourage the authors and the Census Bureau to rethink their overall approach to bringing the World Web on line as an additional mode of data collection, as represented here. First, I believe that the overall approach to data collection that is most likely to be effective is building a mixed-mode data collection system that utilizes the strengths of each mode in a way that supports use of other modes. In some cases this may involve attempting to get people to respond via the web, and for those who will not or cannot, to then follow with a different mode (or vice versa). This kind of approach would suggest very different sorts of communications than one which tries to convince people of the advantages of one mode over another. It also suggests that teams of researcher need to include people with skills in different survey modes. In this way I think the chances of achieving an effective balance between agency interests and respondent interests are likely to be greater.

I look forward with much interest to observing how the Census Bureau approaches web surveying of establishments. I suspect that early successful efforts to survey via the web will inevitably involve mixing survey modes. As a consequence, there are likely to face new measurement issues and the necessity of bringing influence and cognitive psychological perspectives on the design of survey instruments.

In addition, web questionnaires are likely to use quite different formats than the traditional matrix of cryptically written questions, with separate instruction books that has serve as the dominate method of designing self-administered surveys. I expect that the Bureau is likely to use page-by-page web survey construction (instead of scrolling) that emphasizes a prescribed navigational flow through the questionnaire, and that simply transferring current paper questionnaires to the web will not work well. In addition, I expect that the page-by-page construction methods will make it very difficult to print copies of the questionnaire so that the respondent has greater difficulty in getting an overall perspective on questions to be asked, and thus figure out what background work needs to be done prior to starting to fill out the questionnaire. One solution would be to attach a paper questionnaire to e-mail requests so that the respondent can print that questionnaire in order to do the background work essential for going on line and completing the web questionnaire. However, if the paper questionnaire uses the traditional matrix format, and the web questionnaire uses a new and quite different format, it will be difficult for the respondent to use one format in preparation for the other. Consequently, I expect that attempting to shift much of our establishment survey data collection to the web is going to result in the creation of quite different and, I think, much improved paper formats compared to those now in use in order to achieve a common stimulus that reduces measurement error.

Innovation inevitably creates as well as destroys. The challenge facing the designers of web surveys is how to carry forward the good practices of the past and shed the outdated ones while bringing in new methods that are more efficient and effective. Clayton and his colleagues have provided a model for doing that tailored nicely to the needs of one important data collection program, the Current Employment Survey. The other papers in this session illustrate some of the design and implementation challenges that must be faced if other establishment surveys are going to be able to incorporate the use of web questionnaires as a part of the data collection effort. Doing that will require concerted efforts involving much more than simply finding techniques for getting people to respond to web surveys and how to make web surveys work.

Together these three papers leave the impression that something very important is happening in the surveying of establishments. Each provides a somewhat different perspective on use of the web for surveying, and all three perspectives are useful. Thus, each provides a significant contribution that reminds me once again that it is necessary to walk before we run. But, our pace is beginning to quicken.